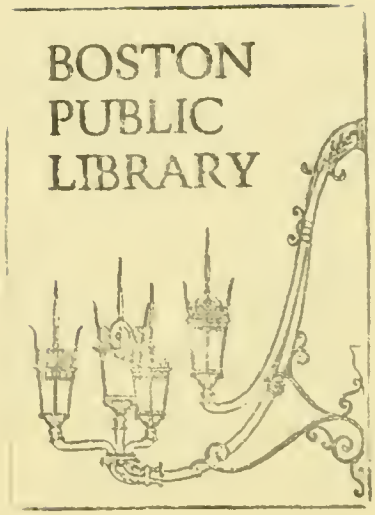
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SPECIAL

BRIDGE TYPE STUDY

for the

REPLACEMENT OF BRIDGE NO.

B-16-164

NORTHERN AVENUE

over

FORT POINT CHANNEL

BOSTON, MASSACHUSETTS

JULY, 1984

ammann & whitney
5 DOANE STREET
BOSTON, MASS.

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SPECIAL TYPE STUDY

NORTHERN AVENUE BRIDGE REPLACEMENT

I INTRODUCTION

A. Background History

This special bridge type study was prepared under the direction of the Massachusetts Executive Office of Transportation and Construction and the Massachusetts Department of Public Works.

In 1970, it was determined that the existing Northern Avenue bridge could not realistically be repaired to last any significant amount of time. As a result of this determination, studies were undertaken by the Department of Public Works on how best to replace the Northern Avenue Bridge. In the last 12-13 years various replacement proposals have been studied. During this study period, in September of 1976, the U.S. Department of the Interior ruled that the Northern Avenue Bridge was a candidate for inclusion on the National Register of Historic Places as a historic landmark. This designation precluded the placement of the new bridge at the same location.

Through the years, numerous engineering, aesthetic and environmental issues have prevented the initiation of the final design for the bridge replacement. Most major issues such as necessity, location, funding, environmental impacts and mitigations have been resolved. It has been decided that a new bridge, located south of the existing bridge, shall be built. The last remaining issue is the type of bridge. The bridge type selection involves three primary considerations:

A. Aesthetic appearance of the bridge and its compatability with the present and future landscape of the area.

B. Navigability of the channel (functional requirements).

C. Economy of design.

This report deals only with the selection of a structure type for the proposed bridge.

The following listed reports are cited and noted as containing a history of the various design alternatives and related concerns:

1. "Replacement of Northern Avenue Bridge and its Approaches over Fort Point Channel, Feasibility Study, Environmental Assessments and Basic Design", 1974, Massachusetts Department of Public Works.

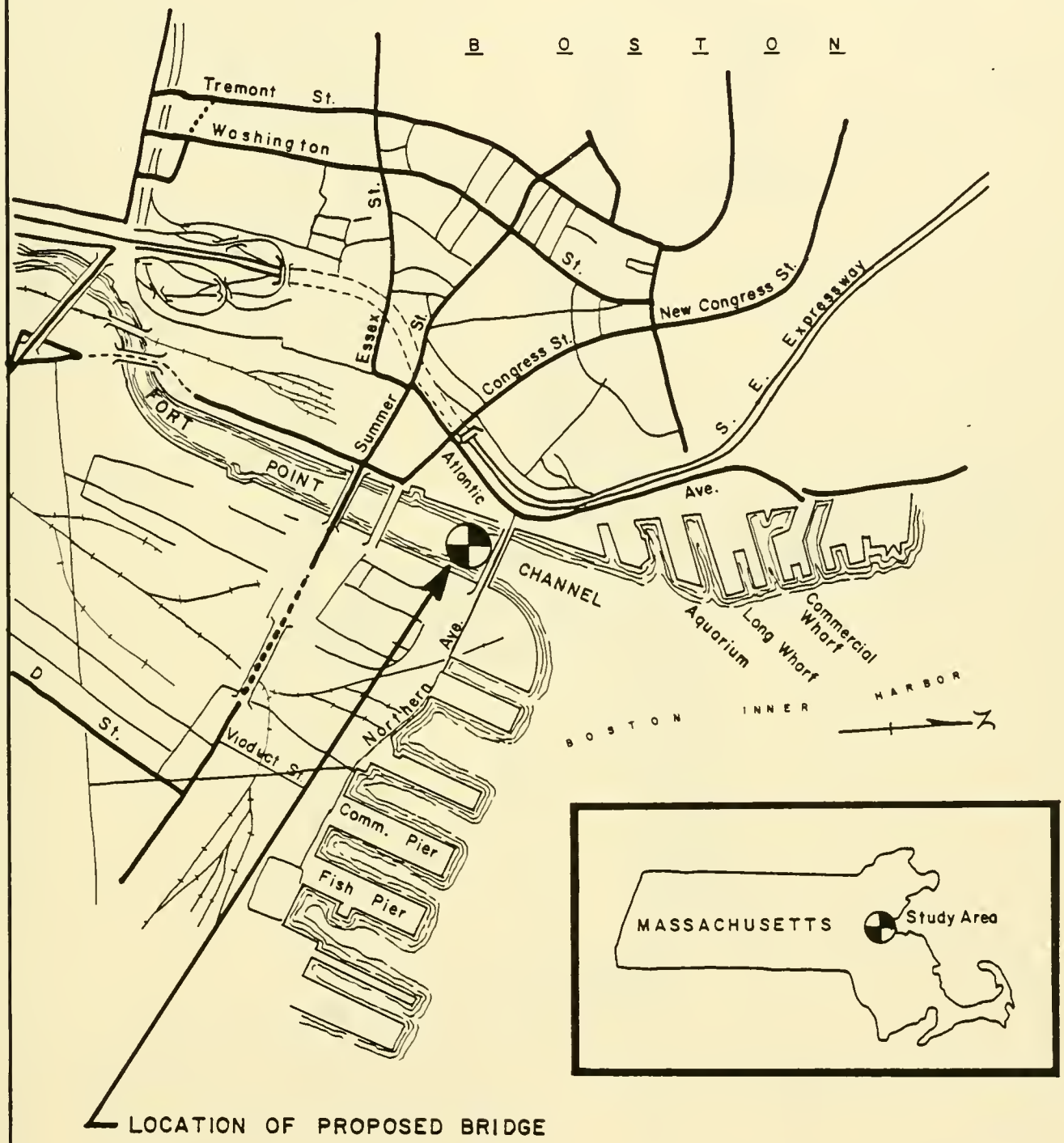
2. "Supplementary Report, Scheme Modified Replacement of Northern Avenue Bridge and its Approaches over Fort Point Channel", 1977, Massachusetts Department of Public Works.

3. Boston Harbor: Challenges and Opportunities for the 1980's Boston Redevelopment Authority.

4. Supplementary Report: Northern Avenue Bridge Replacement Study, January 1980
Boston Redevelopment Authority
Massachusetts Port Authority

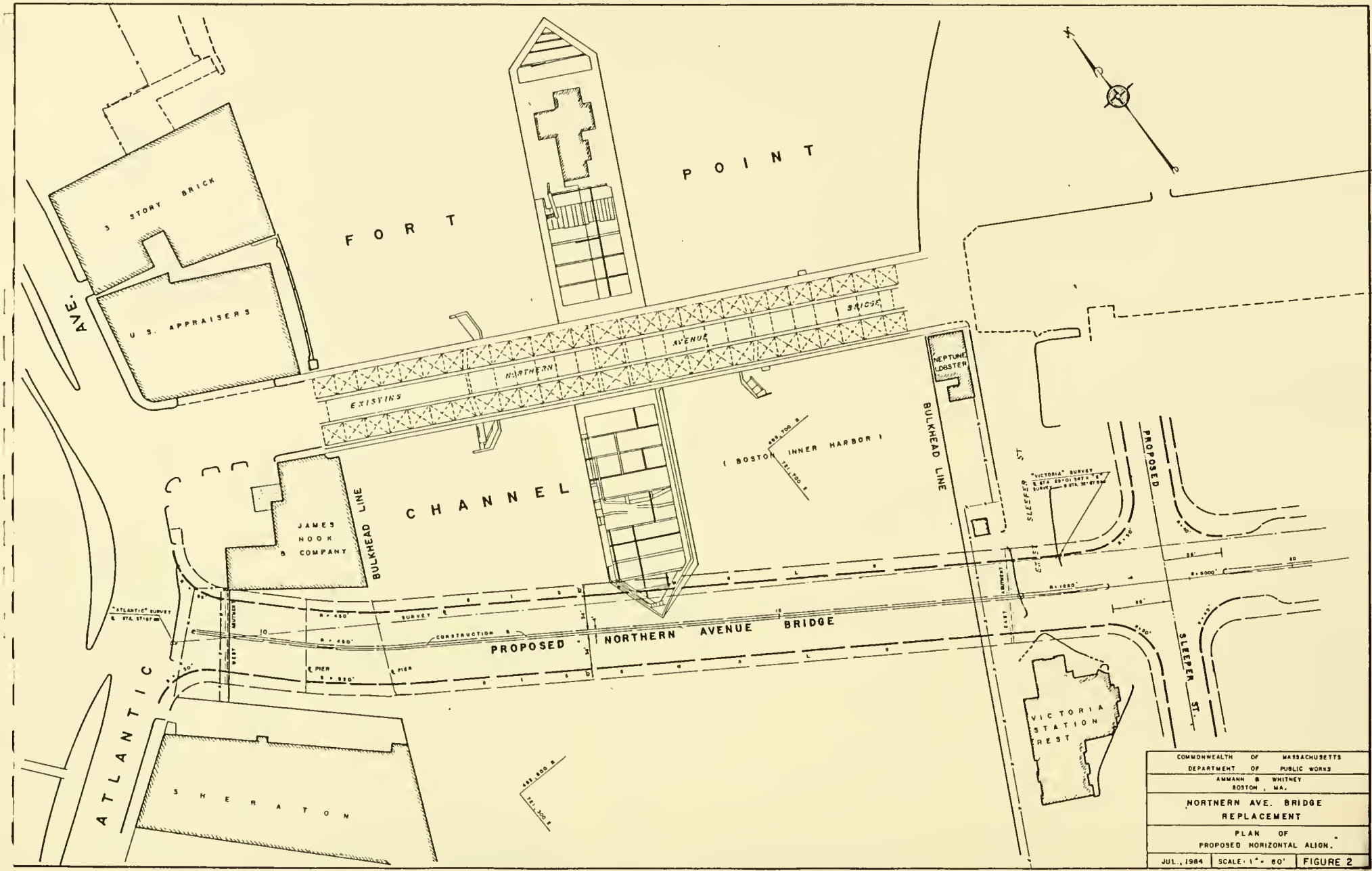
B. Location

The study area (Figure 1) is south of and adjacent to the existing Northern Avenue Bridge over the Fort Point Channel between Downtown Boston and South Boston. The western limit of the project is the intersection of relocated Northern Avenue with Atlantic Avenue. The eastern limit of the project is in the vicinity of Viaduct Street while the eastern bridge limit is at


B O S T O N
Tremont St.
Washington St.
Essex St.
St.
St.
New Congress St
Congress St.
S. E. Expressway
FORT POINT
Summer
Atlantic Ave.
CHANNEL
Commercial Wharf
Long Wharf
Aquarium
Northern Ave.
D St.
Viaduct St.
Comm. Pier
Fish Pier
BOSTON INNER HARBOR
MASSACHUSETTS
Study Area
LOCATION OF PROPOSED BRIDGE

L O C U S

Fig. 1


FORT POINT
3 STORY BRICK
U.S. APPRAISERS
AVE.
EXISTING NORTHERN AVENUE BRIDGE
NEPTUNE LOBSTER
BULKHEAD LINE
CHANNEL
BOSTON INNER HARBOR
JAMES NOOK & COMPANY
BULKHEAD LINE
PROPOSED NORTHERN AVENUE BRIDGE
SLEEPER ST.
PROPOSED
SLEEPER ST.
VICTORIA STATION REST
ATLANTIC
SHERATON
COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS
AMMANN & WHITNEY
BOSTON, MA.
NORTHERN AVE. BRIDGE REPLACEMENT
PLAN OF PROPOSED HORIZONTAL ALIGN.
JUL., 1984
SCALE: 1" = 60'
FIGURE 2

the intersection of Northern Avenue with Sleeper Street. The Boston side of the proposed bridge lies between the Hook Lobster Company and the Sheraton Building while the South Boston side runs north of the existing Victoria Station Restaurant.

C. Approach Roads

On the Boston side, the proposed relocated Northern Avenue will intersect with Atlantic Avenue approximately 180 feet west of the Fort Point Channel to form a tee intersection. On the South Boston side, the proposed relocated Northern Avenue will intersect with Sleeper Street approximately 160 feet east of the Channel, to form a cross intersection.

D. Existing Bridge

The existing Northern Avenue Bridge, owned and maintained by the City of Boston, is one of four bridges over the Fort Point Channel linking Boston's CBD with the industrial/commercial area of South Boston. Constructed in 1907, the bridge is now over 70 years old and reveals the combined effects of age, poor drainage, roadway de-icing salts, the local corrosive atmosphere plus normal wear and tear. This bridge has been repaired and redecked many times in its history, the most recent being emergency repairs made in 1972.

The existing structure consists of a steel through-truss, a horizontal swing center portion, one fixed through-truss span on each approach and a short steel girder span on the east. Truss spans consist of four trusses, with three 19-foot bays open to vehicular traffic. Sidewalks are cantilevered to the outside of each exterior truss. The existing bridge currently accommodates approximately 17,000 vehicular trips daily, of which approximately 1400 are truck trips. It is anticipated in the future, that vehicular movements across this vital link will increase by a significant amount. Presently, the bridge does not meet current state and federal standards. Vehicles are restricted by height and weight, and lane widths are substandard.

II THE PROPOSED BRIDGE

A. General Description

The proposed Northern Avenue Bridge replacement and associated roadway relocation will consist of approximately 2800 feet of new roadway construction. The main channel crossing will be a 620-foot long bridge over the Fort Point Channel south of the existing bridge with two 75-foot approach spans in the slip between the Hook Lobster and Sheraton Building. This will provide for two travel lanes in each direction and a 10 foot wide sidewalk on each side.

The proposed bridge will be designed for AASHTO HS20-44 loading.

The horizontal alignment (Figure 2) will be approximately 130 feet south of the existing Northern Avenue Bridge at the Boston approach and 170 feet south of the existing bridge at the South Boston side. The proposed vertical alignment is designed to meet current safety and drainage standards while maintaining a minimum 16 foot vertical clearance and a 75 foot horizontal opening over the navigable channel.

In order to provide a reasonable vertical profile several restraining factors had to be accommodate. These predominent factors are: maximum gradient; minimum vertical clearance;

preferable wall height at Victoria Station and acceptable profile of Sleeper Street where it will intersect the relocated Northern Avenue.

For fixed bridges, a minimum of a 16 foot vertical clearance over MHW is adequate as the majority of marine traffic in the channel requires less than 16 foot clearance. The tidal deviation at the proposed bridge site is approximately 9.5 feet, thus for emergencies and special situations there will be a clearance of 25.5 feet.

To keep the retaining wall at Victoria Station within a reasonable height (approximately 10 feet) it has been assumed for all bridge profiles that the proposed walkway parallel to Fort Point Channel and crossing under the bridge will be situated in the Channel itself.

Several utilities will be relocated to the proposed bridge. Telephone, gas, electric and steam lines are to be carried across the Fort Point Channel within the utility bays of the bridge.

B. Superstructure Alternatives

The types of superstructures selected for study and evaluation for the main crossing are as follows:

Scheme I: Three continuous spans of welded variable depth steel plate girders with a composite reinforced concrete deck.

Scheme II: Four continuous spans of welded constant depth steel plate girder with a composite reinforced concrete deck.

Scheme III: Twin tower cable stayed orthotropic steel plate deck.

Scheme IV: Single tower cable stayed orthotropic steel plate deck.

Scheme V: Steel tied through truss arch

Scheme VI: Double leaf bascule bridge, with steel plate girder approach spans.

Scheme VII: Single-leaf bascule bridge with trestle type approach spans.

The feasibility of constructing a vertical lift bridge was briefly looked into. The vertical lift alternative was the most expensive of all the bridge types studied. Based on its high cost plus an unpleasing appearance, further evaluation was not performed.

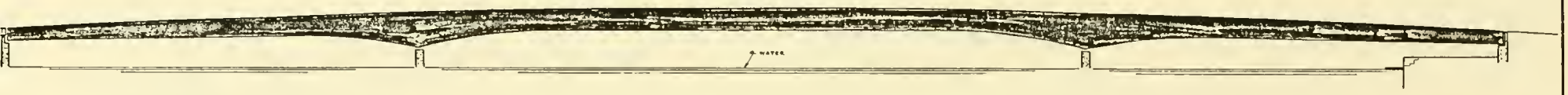
Scheme I is of 3-span continuous variable depth welded steel plate girder construction with a composite reinforced concrete deck. (Figures 3,4, and 5) There will be a bituminous concrete wearing surface with membrane water proofing, over the concrete deck. The span lengths will be approximately 170 feet-272 feet-170 feet. The bridge cross section will consist of two parallel superstructures with each having 4 main girders and 1 rolled beam stringer placed between each main girder. The approximate depth of the main girders will be 8 feet at mid-span of the center span and 12 feet at the piers. The side spans will be approximately 8 feet at the end of the haunch then tapering to 4 feet at the abutments. The channel piers for this scheme will each consist of 2 single hammerhead concrete piers, each supporting one 4-girder superstructure.

Advantages:

1. Pleasing appearance .

2. Increased east span length (versus 4-span plate girder scheme) results in less chance of interference with the existing Boston Edison 115 kv cables crossing under Fort Point Channel.

3. One of the lowest in estimated construction cost of the bridge types studied.



BRIDGE ELEVATION

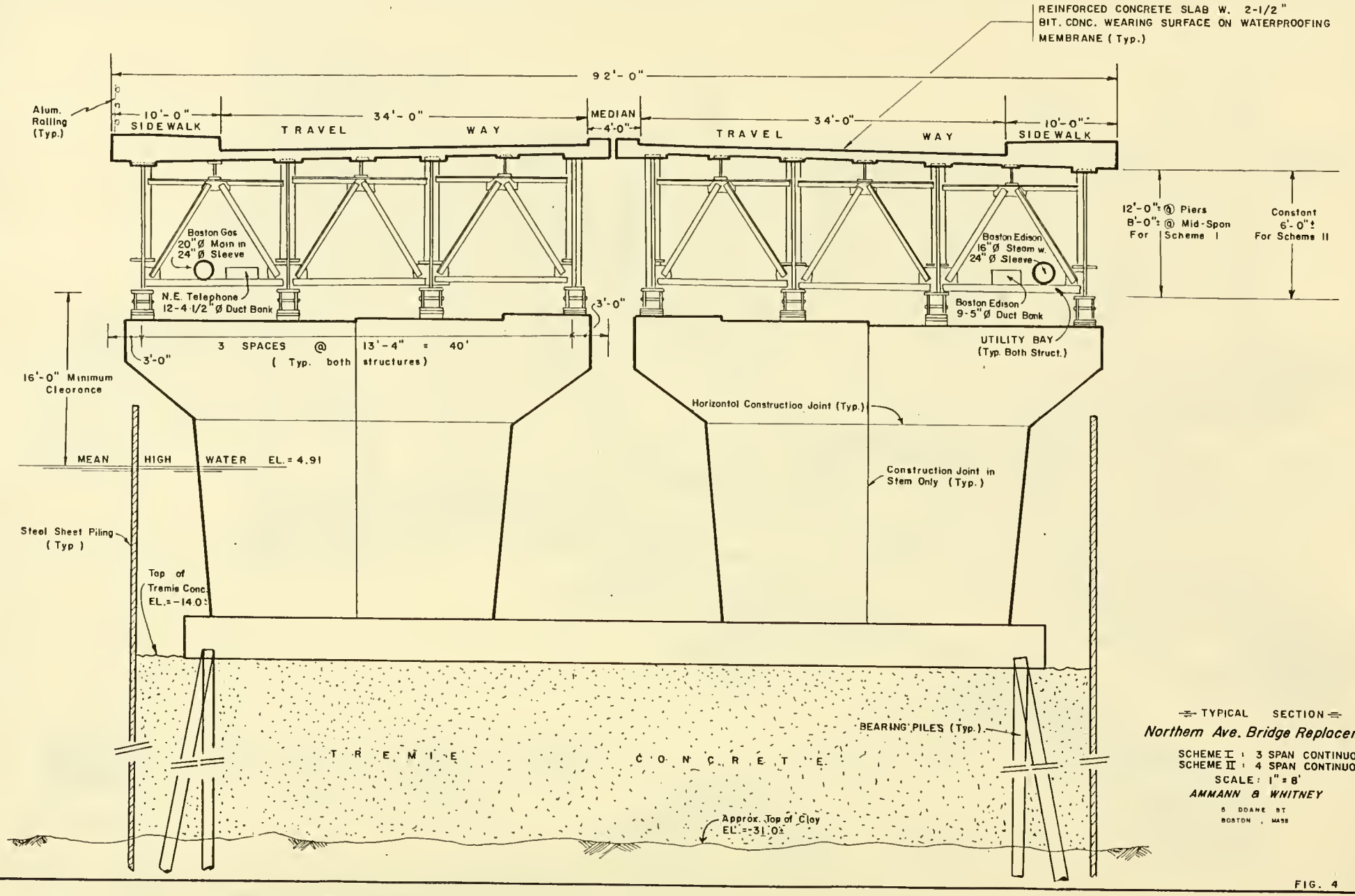
NORTHERN AVE. BRIDGE REPLACEMENT

SCHEME 1 – 3 SPAN CONTINUOUS

SCALE: 1" = 40'

AMMANN & WHITNEY
5 DOANE ST
BOSTON, MASS

FIGURE 3



TYPICAL SECTION

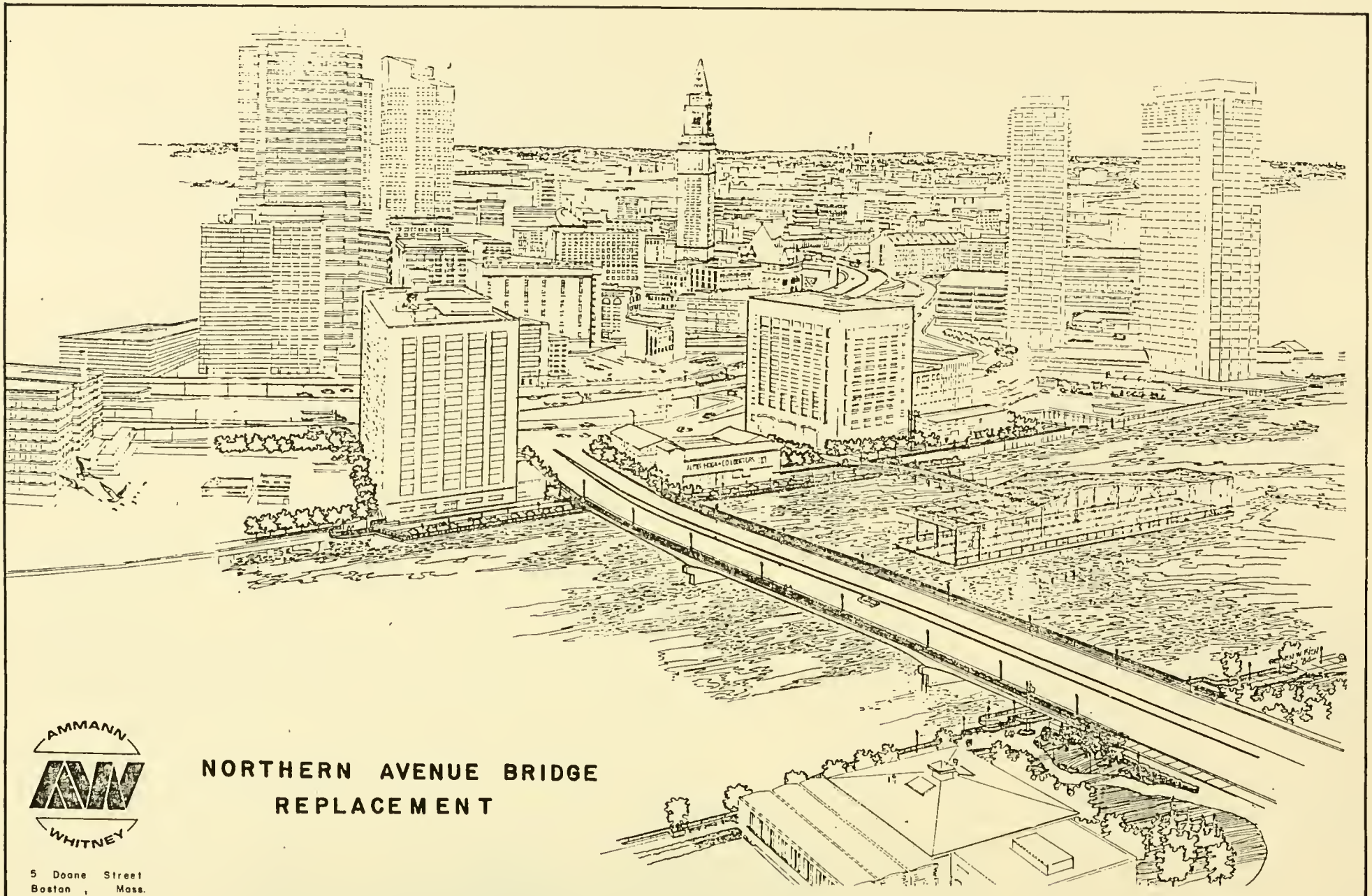
Northern Ave. Bridge Replacement

SCHEME I : 3 SPAN CONTINUOUS
SCHEME II : 4 SPAN CONTINUOUS
SCALE: 1" = 8'

AMMANN & WHITNEY

5 DOANE ST
BOSTON, MASS

FIG. 4



AMMANN
WHITNEY

5 Doane Street
Boston , Mass.

NORTHERN AVENUE BRIDGE REPLACEMENT

FIGURE 5

Disadvantages:

1. Multiple open stringer systems are prone to bird roostings. If this becomes a problem, a wire net can be installed to alleviate it.

Scheme II is of 4-span continuous, welded constant depth steel plate girder construction with a composite reinforced concrete deck. (Figures 4 and 6) There will be a bituminous concrete wearing surface with membrane waterproofing over the concrete deck. The girders will be approximately 6 feet deep. The span lengths will be approximately 148 feet-158 feet-158 feet-148 feet. The cross section will consist of two parallel superstructures with each having 4 main girders with a rolled beam stringer placed between each main girder. The channel piers will each consist of 2 single hammerhead concrete piers, each supporting one half of the superstructure.

Advantages:

1. Shallower superstructure depth improves profile over the 3 span plate girder scheme.

Disadvantages:

1. Possible conflict with existing Boston Edison cables at first South Boston pier.

2. Bird roosting problem same as Scheme I.

BRIDGE ELEVATION

NORTHERN AVE. BRIDGE REPLACEMENT

SCHEME II – 4 SPAN CONTINUOUS

SCALE: 1"=40'

AMMANN & WHITNEY

FIGURE 6

Scheme III is a twin tower cable-stayed bridge. The deck will be an orthotropic steel plate with closed steel ribs. (Figures 7, 8 and 9) The wearing surface will be fiber reinforced asphaltic concrete. An orthotropic steel plate deck of this type (Figure 10) saves considerably on dead weight and also reduces total structural depth, therefore some extra clearance can be gained or if the 16 foot vertical clearance over the channel is maintained both the proposed bridge profile and the Sleeper Street profile can be improved. The ribs will be supported by floorbeams which are supported by two main steel box girders. The deck will be approximately 4 feet deep. These box girders are then supported by the cables from each tower. Each tower will be 2 parallel steel A-frames and be approximately 90 feet high above the M.H.W. level. The cables will be fanned from the towers. The main span will be 280 feet with 170 foot side spans.

The use of the steel deck as an integral part of the bridge superstructure has many advantages. In this type of design, the steel plate, the stiffening ribs and the transverse floor beams are designed as a single deck with the plate acting as the common top flange. This deck structure then acts as part of the main bridge system creating a more rigid structure.

Advantages:

1. Impressive bridge appearance.

2. Orthotropic steel plate deck provides a substantial reduction of dead weight of the superstructure. Substructure cost is reduced due to less dead load, including a reduction in the number of piles required.

3. Shallow deck structure improves Sleeper Street and bridge profiles.

4. Closed-rib deck eliminates under deck bird roosting.

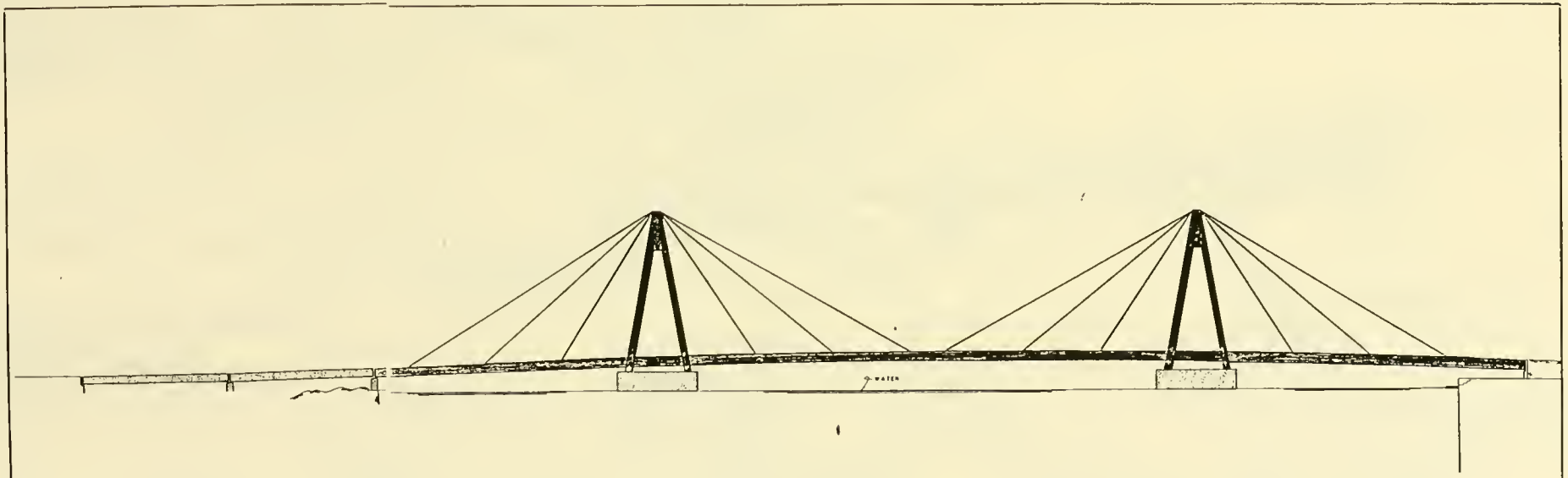
Disadvantages:

1. Approximately 30% more costly than the most economical steel plate girder design.

2. New technique of bridge construction not yet commonly used in this area of the country.

3. It requires that the wearing surface be placed in a more careful manner than standard bridge wearing surfaces.

Scheme IV is a single tower cable-stayed structure. (Figures 9 and 11) The construction of this structure will be similar to



BRIDGE ELEVATION

NORTHERN AVE. BRIDGE REPLACEMENT

SCHEME III – TWIN TOWER CABLE STAYED

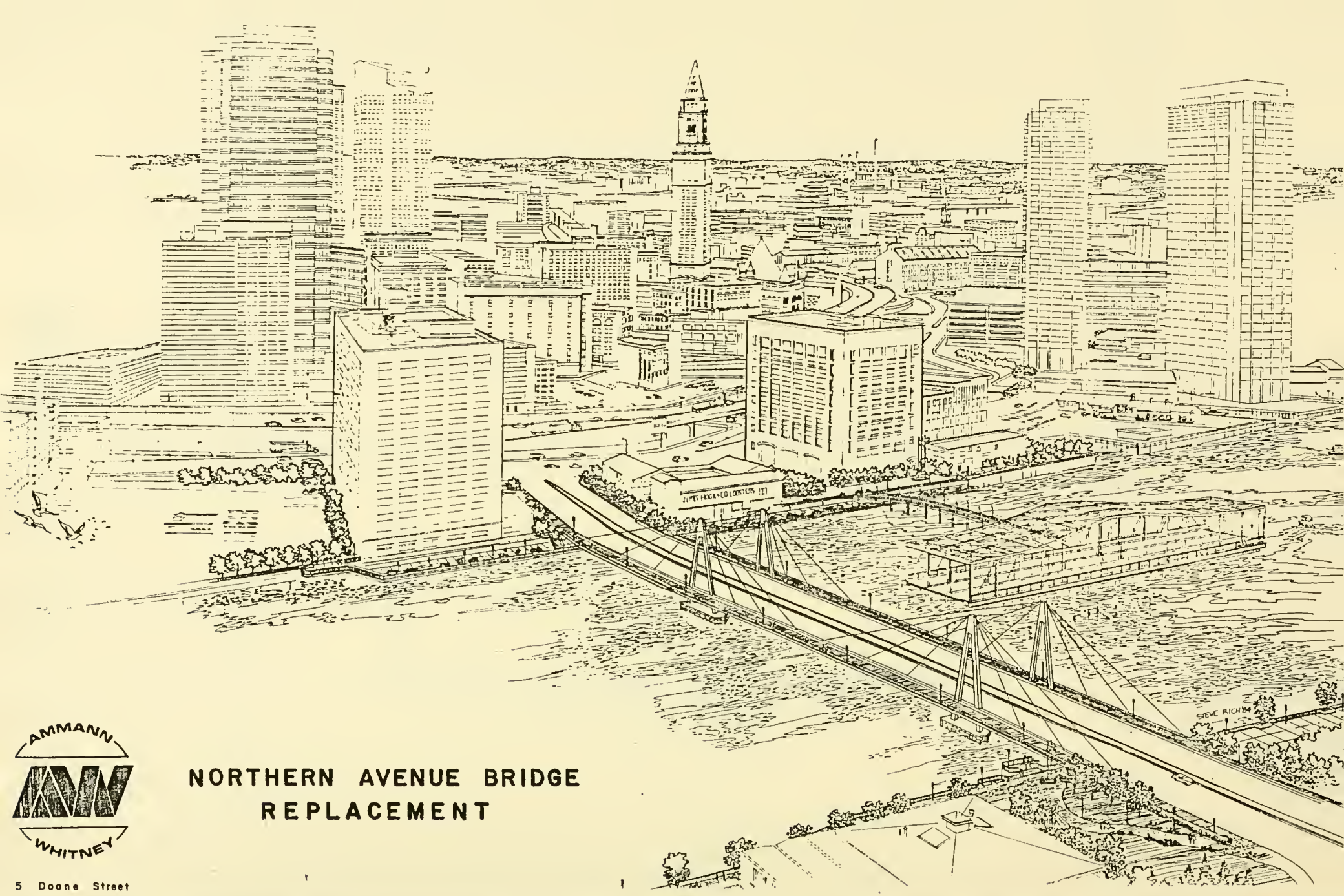
SCALE: 1" = 40'

AMMANN & WHITNEY

6 OCEAN ST

BOSTON, MASS

FIGURE 7

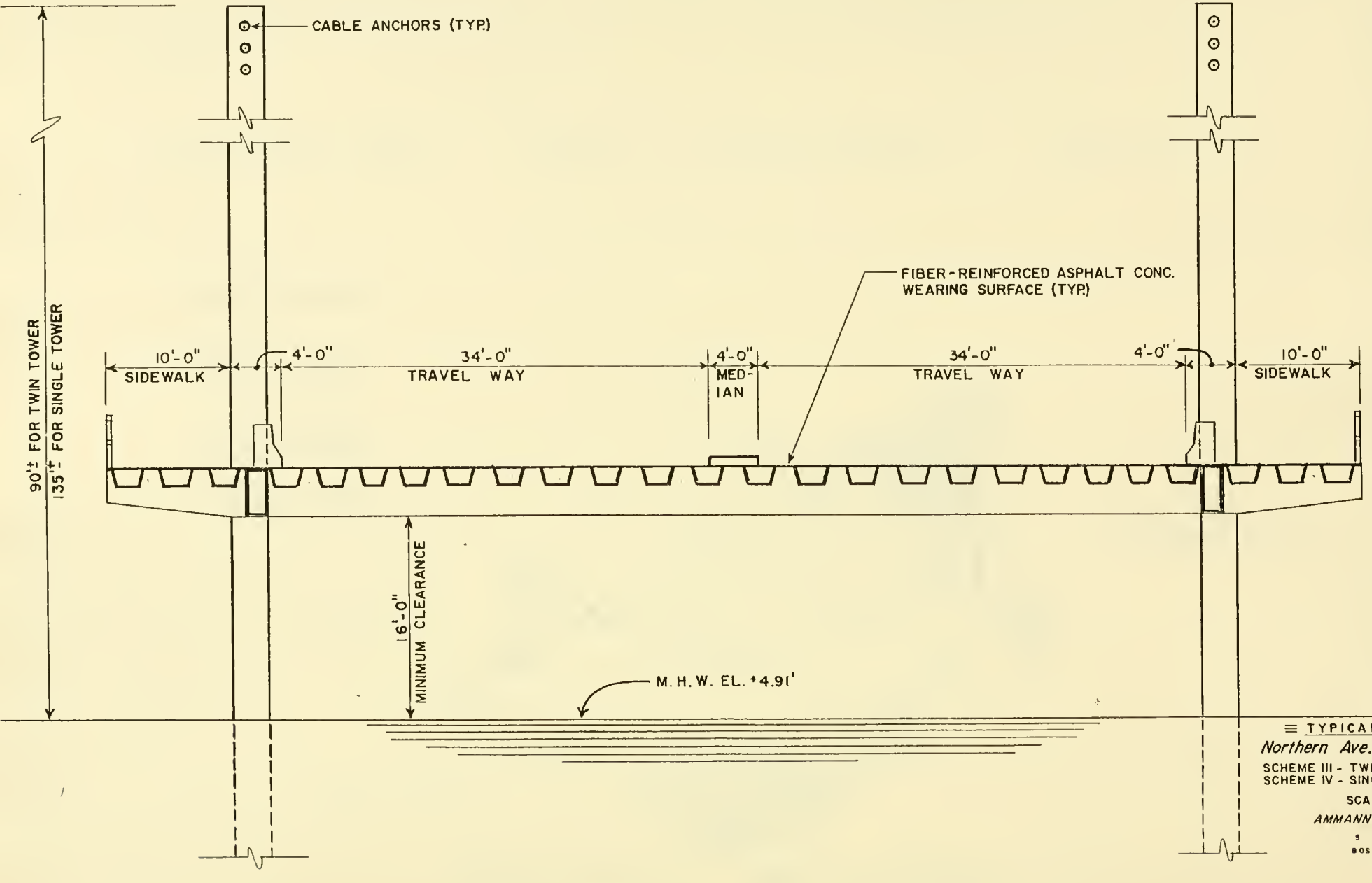


NORTHERN AVENUE BRIDGE REPLACEMENT

AMMANN WHITNEY

5 Doone Street
Boston , Mass.

FIGURE 8



≡ TYPICAL SECTI

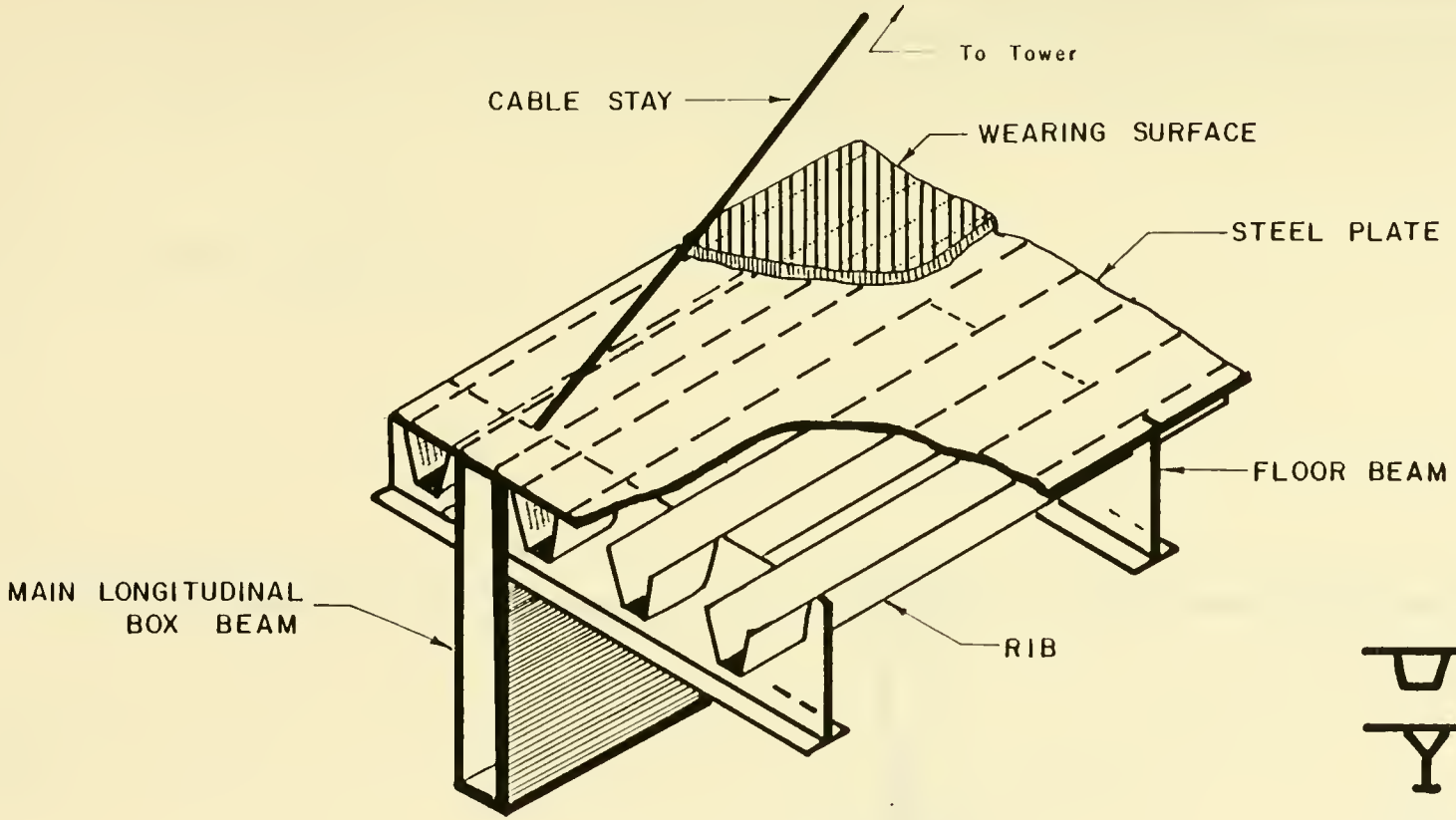
Northern Ave. Bridge R

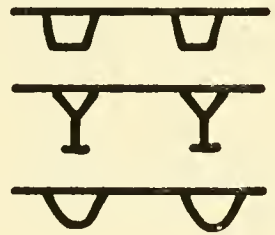
SCHEME III - TWIN TOWER C
SCHEME IV - SINGLE TOWER

SCALE: 1" = 8'

AMMANN & WHITI

5 OOANE ST.
BOSTON, MASS.

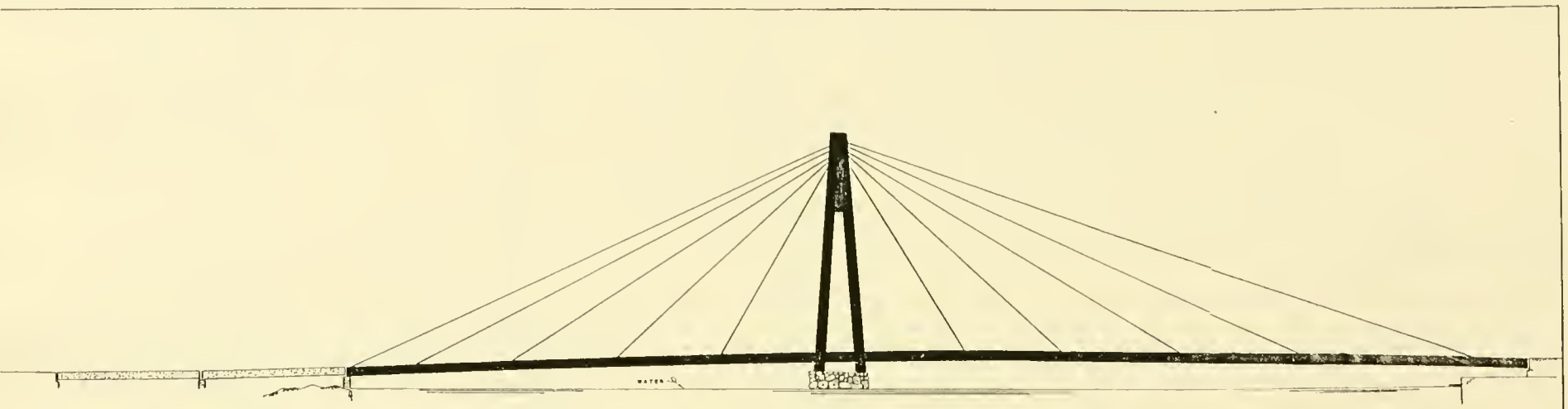




TYPES OF RIBS

TYPICAL ORTHOTROPIC DECK CONSTRUCTION

FIGURE 10



BRIDGE ELEVATION

NORTHERN AVE. BRIDGE REPLACEMENT

SCHEME IV - SINGLE TOWER CABLE STAYED

SCALE: 1" = 40'

AMMANN & WHITNEY

BOSTON, MASS

FIGURE 11

Scheme III except that only one tower will be used. The span lengths will be approximately 260 feet on the Boston side of the tower and approximately 360 feet on the South Boston side. The A-frame towers will be approximately 130 feet above the M.H.W. level.

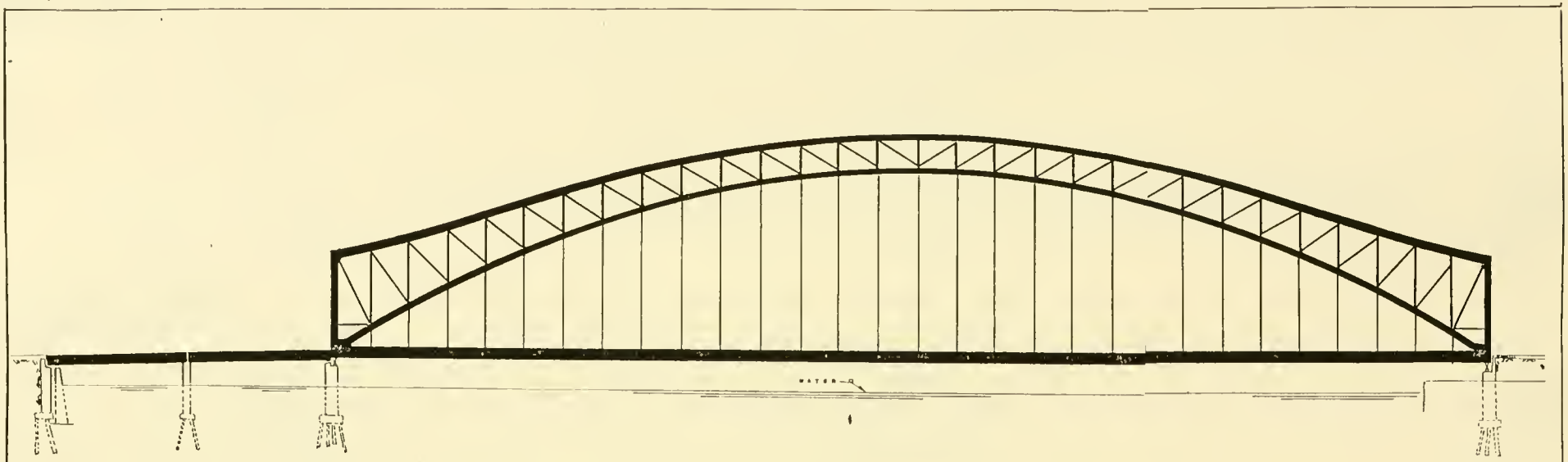
Advantages:

1. This scheme offers no advantages over Scheme III, the twin tower cable stayed bridge.

Disadvantages:

1. A 130 foot high tower will appear to be too imposing for the Fort Point Channel area

Scheme V is a steel tied through arch which spans the 620 foot channel. (Figures 12 and 13) The rise of the arch will be approximately 95 feet from the deck to the intrados of the arch. The superstructure will consist of 3 parallel truss arches of variable depth. The longitudinal ties will be of steel box design and will be supported from the arch by cables. The ties will support floorbeams which in turn, support the concrete deck. The depth of ties will be approximately 7 feet deep and the deck structure 4 feet. The superstructure will be supported by a concrete pier on the Boston side bulkhead line and an abutment on the South Boston side.



BRIDGE ELEVATION

NORTHERN AVE. BRIDGE REPLACEMENT

SCHEME V - TIED ARCHES

SCALE: 1" = 40'

AMMANN & WHITNEY

FIGURE 12

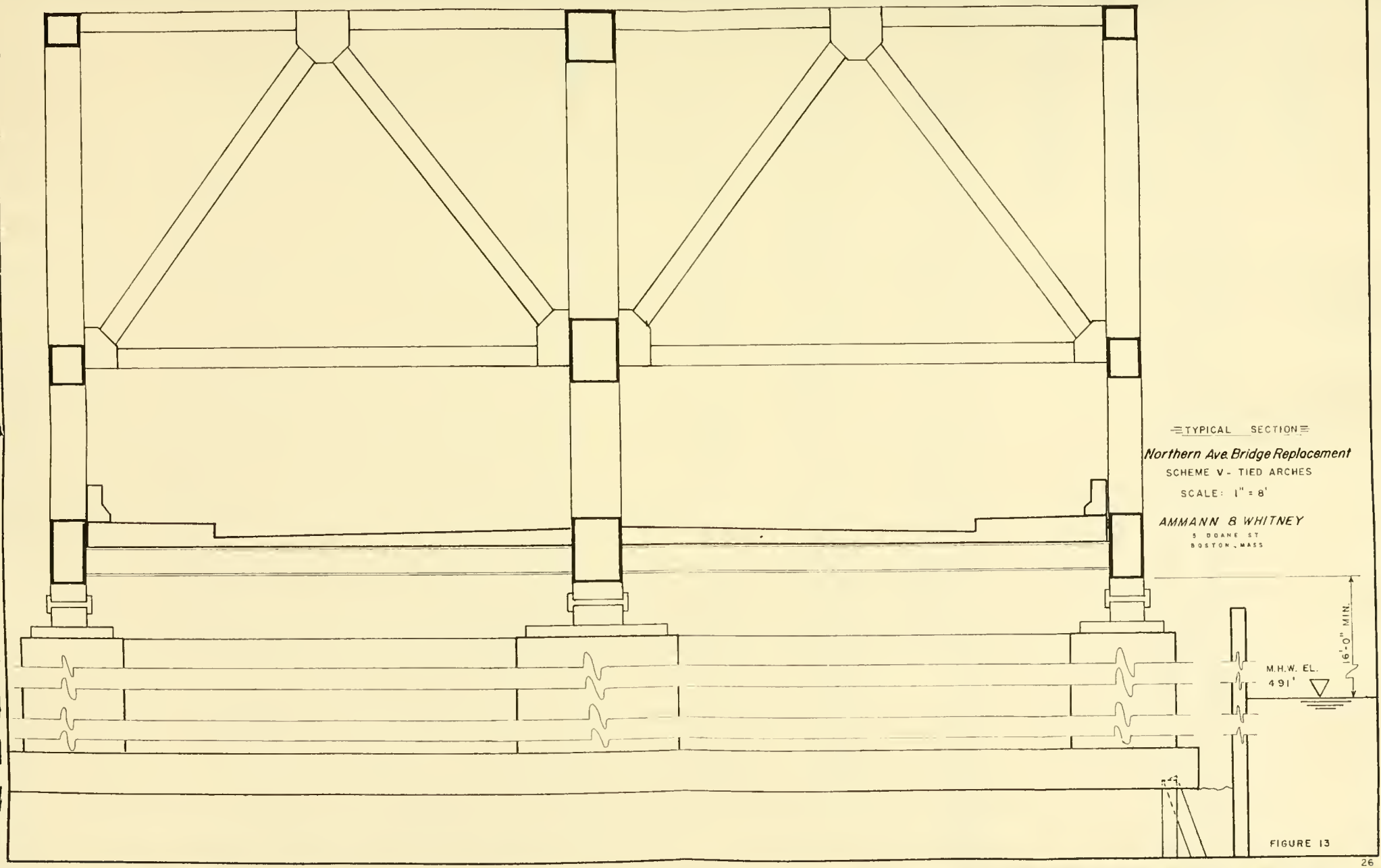

TYPICAL SECTION
Northern Ave. Bridge Replacement
SCHEME V - TIED ARCHES
SCALE: 1" = 8'
AMMANN & WHITNEY
5 DOANE ST
BOSTON, MASS
16'-0" MIN.
M.H.W. EL.
4.91'

FIGURE 13

Advantages:

1. A steel tied through arch has no advantages compared to the other bridge type studies but has several distinct disadvantages.

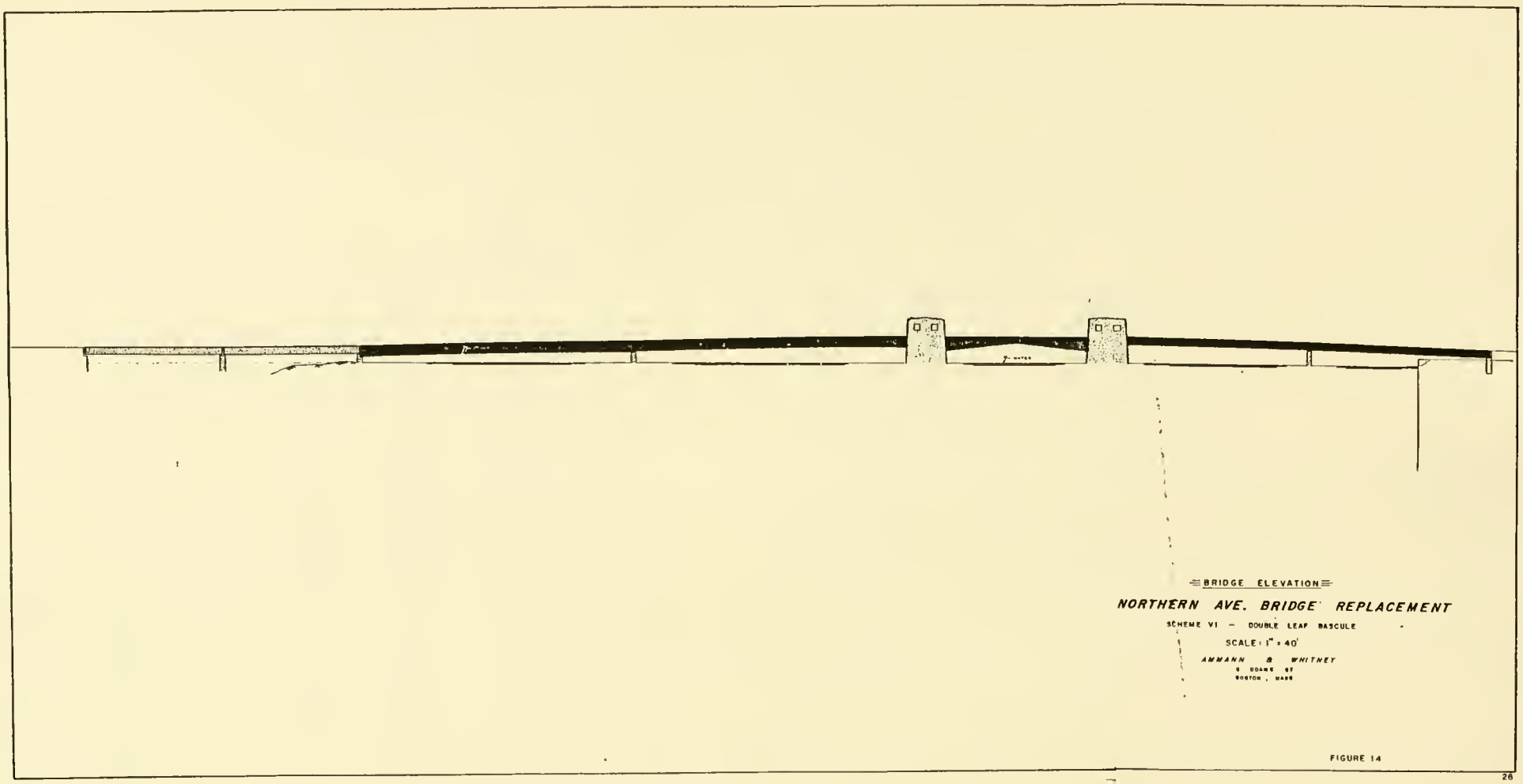
Disadvantages:

1. Size and appearance not appropriate for the Fort Point Channel area and for the vertical clearance required.

2. Numerous exposed structural steel members increase bird roosting problem and maintenance cost.

3. 600 ft. clear waterway opening is not necessary at this location.

Scheme VI is a double leaf bascule bridge.(Figure 14) The bascule bridge will have a minimum of a 75 foot horizontal clearance over the navigable channel. This main channel crossing will be flanked on both sides by two-span continuous welded steel girder approach bridges. The Boston side will be two-150 foot spans approximately 6 feet deep and the South Boston side will be 2-100 foot spans approximately 4.5 feet deep. The bascule bridge and all necessary machinery will be supported by concrete piers. The welded girder approach spans, similar in design to the superstructure in Scheme II will be supported by concrete hammerhead piers.



BRIDGE ELEVATION

NORTHERN AVE. BRIDGE REPLACEMENT

SCHEME VI – DOUBLE LEAF BASCULE

SCALE: 1" = 40'

AMMANN & WHITNEY

6 BOARD ST

BOSTON, MASS

FIGURE 14

Advantages:

1. Provides opening for sailboat traffic.

Disadvantages:

1. Least economical of the schemes studied.

2. Equipment and operational requirements are costly.

3. Waterway traffic has the right-of-way which will cause frequent delay of vehicular traffic.

4. Can not carry any utilities.

Scheme VII is a low profile, trestle type bridge with a single-leaf bascule bridge near the South Boston (Figures 15 and 16) bulkhead line. There will be approximately 35-20 foot spans supported by concrete pile bents. The spans will be composed of multiple 4 feet wide by 1 foot deep prestressed concrete deck beams, tied together by transverse post-tensioning rods . A bituminous concrete wearing surface and membrane waterproofing will be placed over the beams. The bascule bridge will have a minimum of a 40 foot horizontal clearance with the channel starting approximately 40 feet west of the South Boston bulkhead

line. The bascule bridge and all necessary machinery will be supported by concrete piers. For this particular scheme, the two 75 foot precast-concrete beams at the Boston approach (between the Sheraton Building and Hook Lobster) will be replaced with the 20 foot prestressed concrete deck beams.

Advantages:

1. Very shallow deck structure improves Sleeper Street and proposed Northern Avenue Bridge profiles.

2. Provides opening for sailboat traffic.

3. All major components of the bridge can be precast concrete (either reinforced or prestressed) for ease of construction.

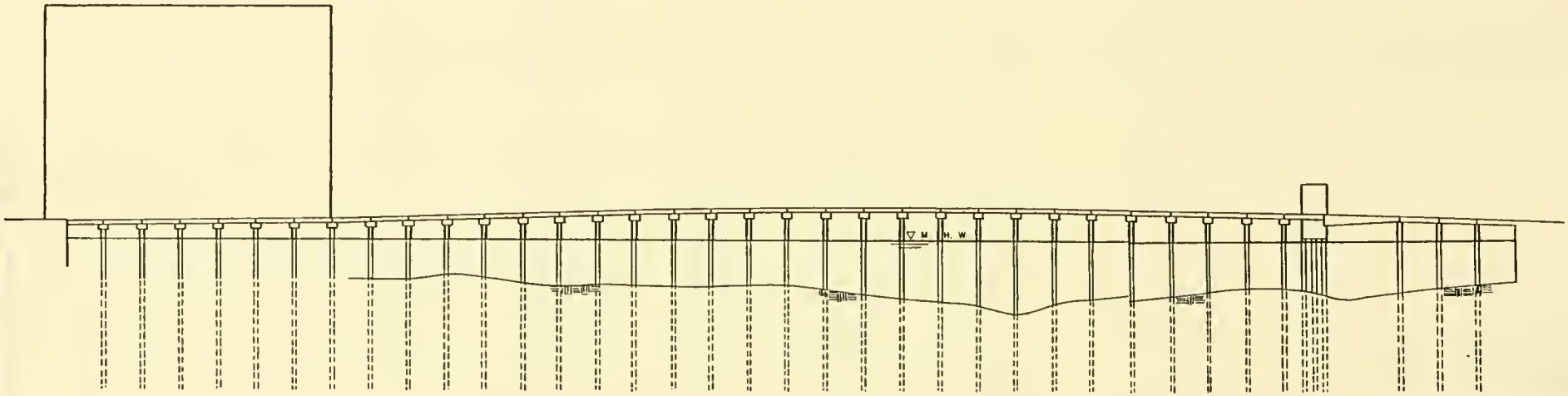
4. Prestressed concrete bridge requires minimal maintenance.

Disadvantages:

1. Possible conflict with existing Boston Edison cables at South Boston side of Channel.

2. Equipment and operational requirements of the bascule bridge are costly.

3. New channel may have to be dredged to provide crossing for larger boats. (Depending where bascule is located)



BRIDGE ELEVATION

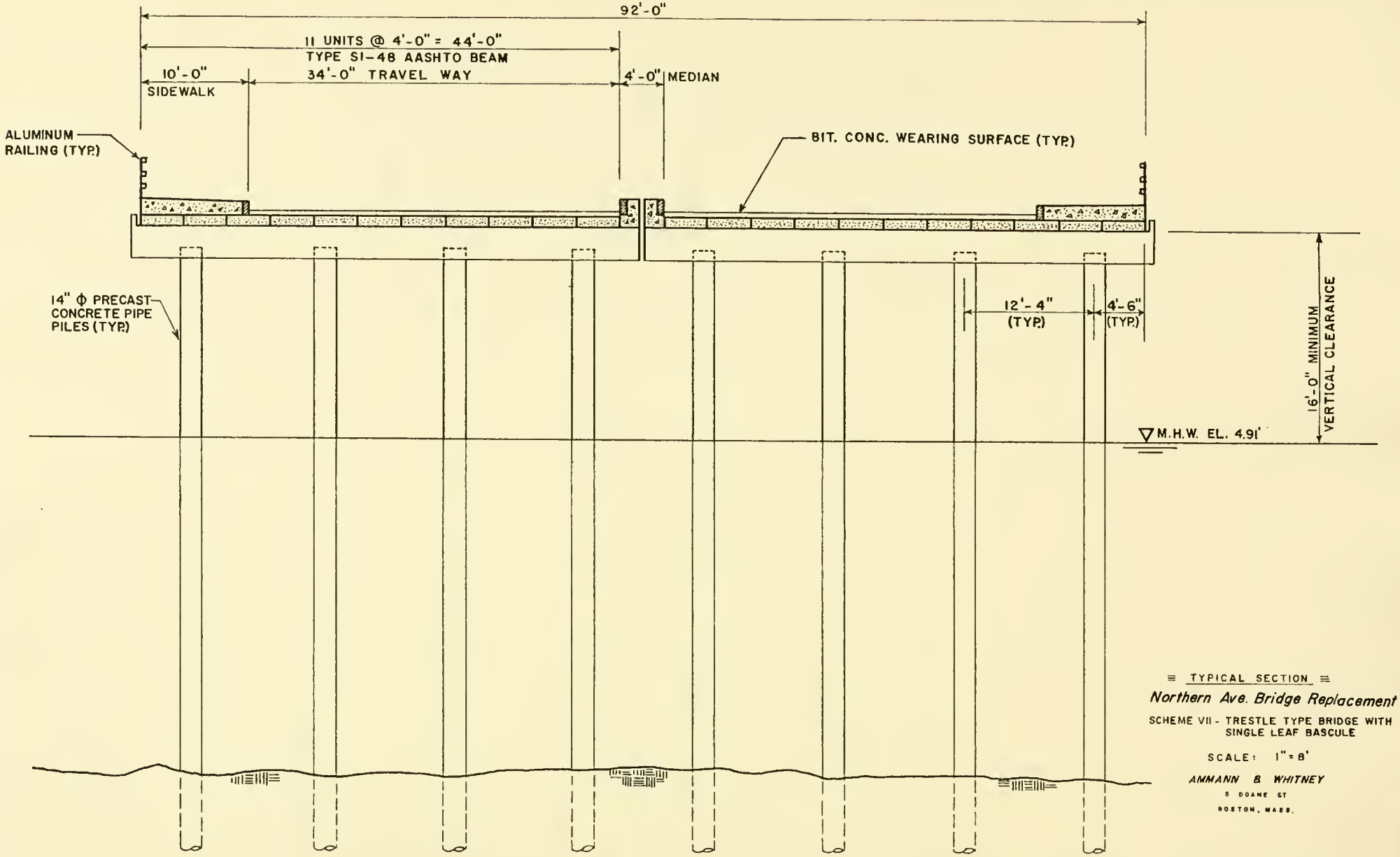
NORTHERN AVE. BRIDGE REPLACEMENT

SCHEME V8 – SINGLE LEAF BASCULE BRIDGE WITH TRESTLE TYPE APPROACH SPANS

SCALE: 1" = 40'

AMMANN & WHITNEY

FIGURE 15



≡ TYPICAL SECTION ≡

Northern Ave. Bridge Replacement

SCHEME VII - TRESTLE TYPE BRIDGE WITH SINGLE LEAF BASCULE

SCALE: 1" = 8'

AMMANN & WHITNEY

5 DOANE ST

BOSTON, MASS.

FIGURE 16

4. Top of concrete beams vulnerable to road de-icing salts which could progressively affect the structural integrity and live load capacity of the bridge.

5. Can not carry utilities

C. Substructure

All foundations for the proposed Northern Avenue Bridge will be supported by piles. The available soil information indicates that end-bearing piles would be used with the piles driven to bedrock.

Solid hammerhead piers are recommended for the reinforced concrete channel supports. The cost difference between solid piers and column bents is negligible and therefore will not have any effect on the type chosen. The solid pier construction affords better resistance to the transverse loads from wind and channel currents, furthermore it prevents the lodging of trees and other large drift between the columns. The piers and abutments will be protected by granite within the tidal range. Pier construction would be in the dry protected by cofferdams sealed at the bottom by tremie concrete.

D. Hydraulics

As described in the 1974 report, Fort Point Channel functions as a tidal drainage system for stormwater and sewage overflow from a tributary area of over 2700 acres.

Since the proposed design for the new Northern Avenue Bridge will not require any embankment in the Channel and will require only two pier supports in the Channel, tidal drainage should not be significantly different than existing conditions. Additionally, the tidal flushing action and peak storm water flows should not be significantly impaired during the construction of the proposed bridge.

III SUMMARY AND RECOMMENDATIONS

Seven schemes have been evaluated for the proposed Northern Avenue Bridge over the Fort Point Channel. Considering economic, structural and aesthetic aspects, it is recommended that the proposed bridge be designed to the requirements of Scheme I - Welded steel plate girder with a variable depth section and 3 continuous spans. Though the impressive appearance of the cable stayed bridge is pleasing aesthetically, the approximately 3 million dollars additional cost to construct this type of bridge cannot be justified.

The merits of a fixed span versus a moveable span must be addressed. As stated previously in this report the vertical lift bridge and the double leaf bascule bridge are both very costly and aesthetically unpleasing; also a 16 foot vertical clearance is adequate for most marine uses. An opened moveable span bridge would cause serious traffic backups onto Atlantic Avenue and the Central Artery. Since Northern Avenue will be the primary arterial serving the new developments in South Boston, frequent bridge openings will be very disruptive, and will have to be curtailed. Finally, any increase in marine traffic would be minimal as boats can go only as far as to Congress Street whose bridge has been made permanently fixed. Therefore a fixed span bridge for Northern Avenue over the Fort Point Channel is recommended.

Finally, landscaping and architectural amenities should be used to enhance the proposed Northern Avenue bridge and its surrounding environment. With the increased development of the Northern Avenue/Fort Point Channel area the proposed bridge will be one of the area's main focal points. It should be intended to beautify the bridge in a manner suitable for one of Boston's major assets. The selection of landscaping and typical flora would be in accordance with applicable established guidelines.

NORTHERN AVENUE BRIDGE REPLACEMENT

Summary of Estimated Construction Costs

(1984 Dollars)

BRIDGE SCHEME	COST $
I. THREE CONTINUOUS SPANS OF WELDED VARIABLE DEPTH STEEL PLATE GIRDERS WITH COMPOSITE REINFORCED CONCRETE DECK.	9,780,000
II. FOUR CONTINUOUS SPANS-WELDED CONSTANT DEPTH STEEL PLATE GIRDER WITH A COMPOSITE REINFORCED CONCRETE DECK.	10,042,000
III. TWIN TOWER CABLE-STAYED ORTHOTROPIC STEEL PLATE DECK.	13,123,000
IV. SINGLE TOWER CABLE-STAYED ORTHOTROPIC STEEL PLATE DECK.	14,144,000
V. STEEL TIED THROUGH TRUSS ARCH.	14,099,000
VI. DOUBLE LEAF BASCULE BRIDGE WITH STEEL PLATE APPROACH SPANS.	19,311,000
VII. SINGLE LEAF BASCULE BRIDGE WITH TRESTLE TYPE APPROACH SPANS.	14,058,000

TABLE I

PRELIMINARY ESTIMATE OF QUANTITIES & COSTS

AMMANN & WHITNEY

NORTHERN AVENUE BRIDGE
TYPE STUDY

SCHEME I - 3 Span Multi-Haunched-Girders

Items	Unit	Price	Quantity	Amount
Main Crossing				
Superstructure				
Concrete	CY	300	2,100	630,000
Reinforcement	Lbs	0.8	396,000	313,000
Str. Steel	Lbs.	1.0	3,740,000	3,740,000
SUB-TOTAL				4,687,000
North Bkhd Pier, South Abutment and Channel Piers				
Struct. Conc.	CY	280	1,500	420,000
Tremie Conc.	CY	150	3,100	465,000
Reinforcement	Lbs.	0.8	117,000	94,000
Temp.Sheet Piling	SF	17	60,000	1,020,000
Fender Piling	LF	25	12,000	300,000
Bearing Piles	LF	30	13,900	417,000
SUB-TOTAL				2,716,000
COMMON ITEMS				
Abut 1, Pier 1, Ret. Wall, slip deck and Beams				
Superstr Conc.	CY	300	540	162,000
Substr. Conc.	CY	280	950	266,000
Tremie Conc.	CY	150	630	95,000
Reinforcement	Lbs.	0.8	170,000	136,000
AASHTO III P/S BMS	LF	140	2,560	359,000
Temp. Sheet Piling	SF	17	10,000	170,000
Bearing Piles	LF	30	6,300	189,000
Miscellaneous	LS	LS	1	1,000,000
SUB-TOTAL				2,377,000
TOTAL				9,780,000

TABLE 2

PRELIMINARY ESTIMATE OF QUANTITIES & COSTS

AMMANN & WHITNEY

NORTHERN AVENUE BRIDGE
TYPE STUDY

SCHEME II - 4 Span Multi Girders

Items	Unit	Price	Quantity	Amount
Main Crossing				
Superstructure				
Concrete	CY	300	2,100	630,000
Reinforcement	Lbs	0.8	396,000	317,000
Str. Steel	Lbs.	0.95	3,100,000	2,945,000
SUB-TOTAL				3,892,000
North Bkhd Pier, South Abutment and Channel Piers				
Struct. Conc.	CY	280	1,800	504,000
Tremie Conc.	CY	150	4,200	630,000
Reinforcement	Lbs.	0.8	145,000	116,000
Temp.Sheet Piling	SF	17	80,000	1,360,000
Fender Piling	LF	25	18,000	450,000
Bearing Piles	LF	30	17,100	513,000
SUB-TOTAL				3,573,000
COMMON ITEMS				
Superstr Conc.	CY	300	540	162,000
Substr. Conc.	CY	280	950	266,000
Tremie Conc.	CY	150	630	95,000
Reinforcement	Lbs.	0.8	170,000	136,000
AASHTO III P/S BMS	LF	140	2,560	359,000
Temp. Sheet Piling	SF	17	10,000	170,000
Bearing Piles	LF	30	6,300	189,000
Miscellaneous	LS	LS	1	1,000,000
SUB-TOTAL				2,377,000
SPECIAL ITEMS				
Boston Edison Cable Interference Contingency				200,000
TOTAL				10,042,000

TABLE 3

PRELIMINARY ESTIMATE OF QUANTITIES & COSTS

AMMANN & WHITNEY

NORTHERN AVENUE BRIDGE
TYPE STUDY

SCHEME III - Twin Tower Cable Stayed Orthotropic Deck

Items	Unit	Price	Quantity	Amount
Main Crossing				
Superstructure				
Str. Steel-Deck	Lbs.	1.20	5,040,000	6,048,000
Tower	Lbs.	1.50	670,000	1,005,000
Stay.Cables	Lbs.	5.80	115,000	667,000
SUB-TOTAL				7,772,000
North Bkhd Pier, South Abutment and Channel Piers				
Struct. Conc.	CY	280	1,500	420,000
Tremie Conc.	CY	150	3,150	473,000
Reinforcement	Lbs.	0.8	117,000	94,000
Temp.Sheet Piling	SF	17	60,000	1,020,000
Fender Piling	LF	25	12,000	300,000
Bearing Piles	LF	30	13,900	417,000
SUB-TOTAL				2,724,000
COMMON ITEMS				
Superstr Conc.	CY	300	540	162,000
Substr. Conc.	CY	280	950	266,000
Tremie Conc.	CY	150	630	95,000
Reinforcement	Lbs.	0.8	170,000	136,000
AASHTO III P/S BMS	LF	140	2,560	359,000
Temp. Sheet Piling	SF	17	10,000	170,000
Bearing Piles	LF	30	6,300	189,000
Miscellaneous	LS	LS	1	1,000,000
SUB-TOTAL				2,377,000
SPECIAL ITEMS				
Safety Barriers				50,000
50 Years Maintenance Differential-Present Value				200,000
TOTAL				13,123,000

TABLE 4

PRELIMINARY ESTIMATE OF QUANTITIES & COSTS

AMMANN & WHITNEY

NORTHERN AVENUE BRIDGE
TYPE STUDY

SCHEME IV - Single Tower Cable Stayed Orthotropic Deck

Items	Unit	Price	Quantity	Amount
Main Crossing				
Superstructure				
Str. Steel - Deck	Lbs.	1.20	5,940,000	7,128,000
Tower	Lbs.	1.50	790,000	1,185,000
Stay Cables	Lbs.	5.80	204,000	1,183,000
SUB-TOTAL				9,496,000
North Bkhd Pier, South Abutment and Channel Piers				
Struct. Conc.	CY	280	1,200	336,000
Tremie Conc.	CY	150	2,100	315,000
Reinforcement	Lbs.	0.8	99,000	79,000
Temp.Sheet Piling	SF	17	45,000	765,000
Fender Piling	LF	25	7,000	175,000
Bearing Piles	LF	30	11,700	351,000
SUB-TOTAL				2,021,000
COMMON ITEMS				
Superstr Conc.	CY	300	540	162,000
Substr. Conc.	CY	280	950	266,000
Tremie Conc.	CY	150	630	95,000
Reinforcement	Lbs.	0.8	170,000	136,000
AASHTO III P/S BMS	LF	140	2,560	359,000
Temp. Sheet Piling	SF	17	10,000	170,000
Bearing Piles	LF	30	6,300	189,000
Miscellaneous	LS	LS	1	1,000,000
SUB-TOTAL				2,377,000
SPECIAL ITEMS				
Safety Barriers				50,000
50 Years Maintenance Differential Present Worth				200,000
TOTAL				14,144,000

TABLE 5

PRELIMINARY ESTIMATE OF QUANTITIES & COSTS

AMMANN & WHITNEY

NORTHERN AVENUE BRIDGE
TYPE STUDY

SCHEME V - Tied Arches

Items	Unit	Price	Quantity	Amount
Main Croassing				
Superstructure				
Concrete	CY	300	2,300	690,000
Reinforcement	Lbs	0.8	420,000	336,000
Str. Steel - Deck and Arch	Lbs.	1.3	6,900,000	8,970,000
SUB-TOTAL				9,996,000
North Bkhd Pier, South Abutment and Channel Piers				
Struct. Conc.	CY	280	810	227,000
Tremie Conc.	CY	150	900	135,000
Reinforcement	Lbs.	0.8	72,000	58,000
Temp.Sheet Piling	SF	17	25,000	425,000
Bearing Piles	LF	30	13,000	390,000
SUB-TOTAL				1,235,000
COMMON ITEMS				
Abut 1, Pier 1, Ret. Wall, slip deck and Beams				
Superstr Conc.	CY	300	540	162,000
Substr. Conc.	CY	280	950	266,000
Tremie Conc.	CY	150	630	95,000
Reinforcement	Lbs.	0.8	170,000	136,000
AASHTO III P/S BMS	LF	140	2,500	350,000
Temp. Sheet Piling	SF	17	10,000	170,000
Bearing Piles	LF	30	6,300	189,000
Miscellaneous	LS	LS	1	1,000,000
SUB-TOTAL				2,368,000
SPECIAL ITEMS				
Safety Barriers				100,000
50 Years Maintenance Differential Present Worth				400,000
TOTAL				14,099,000

TABLE 6

PRELIMINARY ESTIMATE OF QUANTITIES & COSTS

AMMANN & WHITNEY

NORTHERN AVENUE BRIDGE
TYPE STUDY

SCHEME VI - Double Leaf Bascule Bridge with Steel Plate Girder Approach Spans.

Items	Unit	Price	Quantity	Amount
Main Crossing				
Superstructure				
Concrete	CY	300	1,500	450,000
Reinforcement	Lbs	0.8	180,000	144,000
Str. Steel - Deck	Lbs	0.95	2,790,000	2,650,000
Bascule and Tower	LS		1	3,400,000
Equipment	LS		1	2,000,000
SUB-TOTAL				8,644,000
North Bkhd Pier, South Abutment and Channel Piers				
Struct. Conc.	CY	280	1,800	504,000
Tremie Conc.	CY	150	4,200	630,000
Reinforcement	Lbs	0.8	144,000	115,000
Temp.Sheet Piling	SF	17	64,000	1,090,000
Fender Piling	LF	25	18,000	450,000
Bearing Piles	LF	30	17,000	510,000
SUB-TOTAL				3,299,000
COMMON ITEMS				
Abut 1, Pier 1, Ret. Wall, slip deck and Beams				
Superstr Conc.	CY	300	540	162,000
Substr. Conc.	CY	280	950	266,000
Tremie Conc.	CY	150	630	95,000
Reinforcement	Lbs.	0.8	170,000	136,000
AASHTO III P/S BMS	LF	140	2,500	350,000
Temp. Sheet Piling	SF	17	10,000	170,000
Bearing Piles	LF	30	6,300	189,000
Miscellaneous	LS	LS	1	1,000,000
SUB-TOTAL				2,368,000
SPECIAL ITEMS				
50 Years Operational Cost Present Value				5,000,000
TOTAL				19,311,000

TABLE 7

PRELIMINARY ESTIMATE OF QUANTITIES & COSTS

AMMANN & WHITNEY

NORTHERN AVENUE BRIDGE
TYPE STUDY

SCHEME VII - Single Leaf Bascule Bridge With Trestle Type Approach Spans

Items	Unit	Price	Quantity	Amount
Main Crossing				
Superstructure				
Concrete Beams	LF	140	16,600	2,324,000
Bascule and Tower	LS	LS	1	2,200,000
Equipment	LS	LS	1	1,300,000
SUB-TOTAL				5,824,000
Substructure				
Struct. Conc.	CY	300	500	150,000
Reinforcement	Lbs	0.8	100,000	80,000
Fender Piling	LF	25	18,000	450,000
Bearing Piles	LF	25	29,000	725,000
SUB-TOTAL				1,405,000
COMMON ITEMS				
Abuts, Ret. Wall,				
Substr. Conc.	CY	280	1,000	280,000
Reinforcement	Lbs.	0.8	55,000	44,000
Temp. Sheet Piling	SF	17	10,000	170,000
Bearing piles	LF	30	4,500	135,000
Miscellaneous	LS	LS	1	1,000,000
SUB-TOTAL				1,629,000
SPECIAL ITEMS				
50 Years Operational Cost Present Value				5,000,000
Boston Edison Cable Interference Contingency				200,000
TOTAL				14,058,000

TABLE 8

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